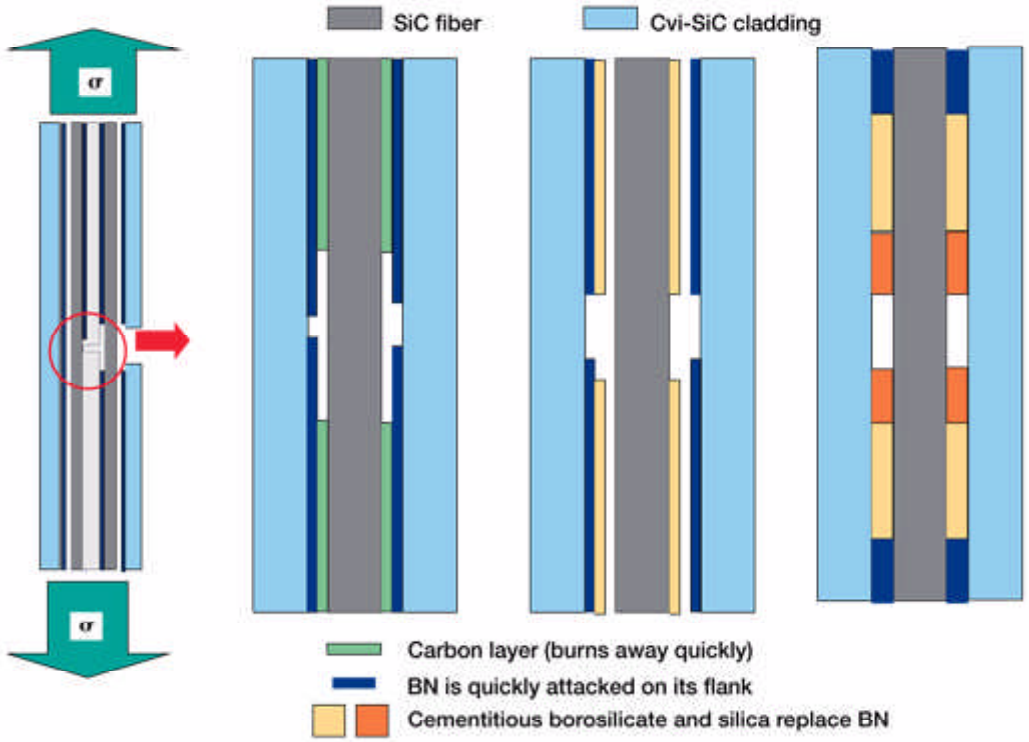
Knowledge of Pest Resistance in SiC/BN/SiC Composites Improved

Ceramic-matrix composites (CMC's) consisting of a silicon carbide matrix reinforced with boron-nitride- (BN-) coated silicon carbide (SiC) fibers are strong contenders for commercial and aerospace applications (in particular, the hot sections of high-performance turbine engines in advanced aircraft and generators). They have very good mechanical properties below ~600 °C and above ~1000 °C. Between those temperatures, however, the BN coating oxidizes easily, and the oxidation of the SiC matrix is too sluggish to seal off the composite with a protective layer of silica. In that temperature interval, the preferential oxidation of the BN weakens and embrittles the composite. That phenomenon, referred to as "pest" degradation, is the focus of this work, which aims to identify the causes of and remedies for pesting.

Previous work established that pesting in Hi-Nicalon (Nippon Carbon Co., Ltd., Japan)/SiC composites was caused by a layer of free carbon that undermined the oxidation resistance of the BN. New work suggests that composites containing a source of carbon are prone to severe pesting and that those that are free of elemental carbon are resistant to pesting. Pest resistance was assessed by exposing machined samples for 100 to 150 hr in an atmospheric burner rig at 600 to 1100 °C, followed by a tensile fracture test to measure residual mechanical properties and by characterization of the interphase microstructure. Whether the elemental carbon came from intrinsic or extrinsic sources, its presence induced the tensile strength to drop by over 50 percent in the burner rig, with an even more severe loss of fracture strain. The schematic figure indicates a likely mechanism by which burnoff of the carbon layer exposes the BN to accelerated flank attack by ambient oxidants. The BN is replaced with borosilicates that attack the fiber, and ultimately with silica that embrittles the composites by rigidly bonding components.

Thus, the study has shown that pesting can be prevented in SiC/BN/SiC, or at least reduced, by simply excluding free carbon. These studies continue, and plans for future work include investigating the role that carbon may play elsewhere in the interphase region.



Effects of carbon in SiC/BN/SiC pesting.

Long description

Set of schematic illustrations. The first illustration shows the interphase area of a SiC/BN/SiC composite intersected by a crack from the outside. The other three depict a progression in which the carbon sublayer burns away, exposing the flanks of the BN interphase for extended attack by oxidants, finally replacing the BN with borosilicates and silica, which are the oxidation products.

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